PHYSICS

"Silent Sound" Works Wonders

Probing deep into the human body to record pulsations of blood, cleaning everything from guided missile engines to fossils are among the many uses of ultrasonics.

By BARBARA TUFTY

➤ IN THE stillness of a hospital room, a beam of silent sound probes deeply into a man's inner organs. Harmless ultrasonic waves can now be directed by a new medical instrument toward specific arteries supplying deep-lying organs such as the kidney, liver or brain.

No surgery is required in this latest development of inspection by ultrasonic equipment using sound waves too highly pitched to be heard by human ears. Doctors obtain vital data from the body's interior by determining the amount of time a wave echo takes to return from its reflector, and by the amplitude and phase diffraction of the returning signals.

One ultrasonic instrument (Bisonar-200, developed by the Sonomedic Corporation of Westwood, N. J.) can measure and record internal arterial pulsations in precise areas and at specific depths. Only 22 inches long and 14½ inches high, it weighs 50 pounds. With ultrasonic beams one centimeter wide, the movement of the heart's valves and walls can be measured and recorded, as well as the brain's mid-line, and dimensions of various organs and bones.

This is only a small part of the new world of ultrasonics now being developed in man's unceasing search for technical knowledge.

Applied Uses of Ultrasonics

Scientists have only recently begun to understand the power of this ultrasonic energy and to channel it into applied uses. There is the dog whistle that is inaudible to human ears but brings dogs running. Underwater sonar systems and supersonic air missiles were used during World War II. The science of ultrasonics has rapidly expanded within the past decade into efficent processes that are affecting modern industry, hospitals, agriculture, aircraft, submarines and space missiles.

Dirt and scum can now be washed, or vibrated, clean from objects as modern as missile assemblies and engines, or as ancient as some 200 million-year-old marine fossils.

In industry, radioactive fuel elements can be tested, metals can be welded without fusion or soldered without flux, and flaws can be detected in solids or contaminants in liquids.

The thickness of a live hog's backfat can be measured by the echoes of ultrasonic vibrations, and insects might be controlled by raising the intensity of sound so high as to kill or repulse them.

In empty warehouses, a creeping burglar can be detected by the change he brings about in the pitch of the ultrasonic wave echoes.

In medicine, ultrasonic energy is being used in place of a needle injector to drive a hydrocortisone drug in ointment form into the underlying muscles of laboratory pigs at the University of Pennsylvania School of Allied Medical Professions.

How Sound Travels

Sound is produced by vibrations of an object and is transmitted in a series of alternate increases and decreases in pressure that radiate outward through a material media of molecules—somewhat like waves spreading out on a pond after a rock has been tossed in the water.

These vibrations travel through air, liquids and solids at different speeds: about 1,100 feet per second in air, 4,700 feet per second in water and 15,000 feet per second in metal. Because there are no molecules in a vacuum, sound vibrations cannot pass through empty space.

The frequency of sound is determined by the number of times the vibrating waves undulate per second, and is measured in cycles per second. The slower the cycle of waves, the lower the sound. As the frequencies increase, the sound rises higher.

Sound is audible to human beings only if the frequency falls within a certain range.

The human ear is usually not sensitive to frequencies of less than 20 vibrations per second, or more than about 20,000 vibrations per second—although this range varies greatly among different individuals. Anything at a pitch higher than the human ear can hear is termed "ultrasonic."

Intensity or loudness is the strength of the pressure of these radiating waves, and is measured in decibels. The human ear responds to intensity in a range from zero to 120 decibels. Any sound with pressure over 120 decibels is painful. But intensities in the frequency wavelength of less than 20 or more than 20,000 vibrations per second have little or no effect on human ears. Thus very high intensities can be set up in silent, inaudible sounds out of range of the human ear.

Westinghouse

ULTRASOUND FOR CLEANING —Thousands of bubbles, agitated by ultrasonic vibrations, are compressed and collapsed with explosive force to clean this piece of metal casting from a car crankcase.

Remarkable Cleaning Effect

When a liquid is agitated with vibrations higher than the human ear can hear, scientists have found that a remarkable cleaning effect is created that lifts dirt from all surfaces in a matter of seconds.

This is the way it works:

Every liquid contains thousands of bubbles ranging in size from those visible to the naked eye to those that are submicroscopic. As this liquid is agitated by mechanical vibrations (which have been converted from high frequency electrical energy by a transducer), these bubbles are compressed, agitated and collapsed, generating forces of 15,000 or more pounds per square inch at the center of implosion.

This exploding force and pulsating action of bubbles act like countless tiny fingers, reaching into otherwise impenetrable crevices, blind holes and interstices, and scrubbing under the film of dirt, grease or scum to separate it from the surface.

An interesting phenomenon is set up with the pressure of the sound waves which seems to direct and drive the bubbles against the junction of the film and the surface to be cleaned. As a portion of the film is lifted free from the surface, some of the sound energy is absorbed, thus lessening the sonic pressure at the junction, and other pulsating bubbles flow into the area.

With this method, contaminants can be lifted from surfaces of small precision parts at a rate unattainable before, and to a degree of cleanliness that usually surpasses the most stringent industrial standard. Ball bearings, electric shaving heads, valves, tubing, wire mesh and countless other objects can be cleaned without having to take them apart or without being touched by conventional cleaning materials.

In atomic power plants, radioactive materials and scale can be removed from fuel

rods and control rods. Before the development of ultrasonic cleaners, jet-engine nozzles and oil filters had to be thrown away when dirty.

The ancient art of welding metals has also been modernized by ultrasonic science. Without the use of heat, two metals can now be rubbed and vibrated together with such force that they exceed their natural rigidity and flow together to form a permanently welded piece.

Soldering also is undergoing vast changes with this new method. The ultrasonic process can wash off the hardest corrosive crusts in molten metal even at red heat, and prepare it for the quick soldering that gives a stronger, more permanent bond, even with unusual and normally incompatible materials such as silicon, germanium, aluminum, copper, silver and magnesium.

Chemical substances can be mixed that cannot be mixed in any other way, with resulting compounds that are more stable than those mixed in conventional methods.

Railroad tracks can be tested for deep flaws, as well as generators, or the wings and struts of a plane or the girders of a bridge.

By sending a vibrating ultrasonic wave through the material to be tested, scientists can spot a change of metal structure by a change in the velocity of the wave and its echo. The short ultrasonic wavelengths indicate these flaws in greater detail than formerly could be seen.

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METEOROLOGY

Frost Recedes North

Spring and warm weather advance north at about 15 miles a day, bringing the great stirrings of life to most of the United States by the end of May.

➤ THE FLOOD TIDE of spring and warm weather advances north at the rate of about 15 miles a day—flowing first through low valleys, along the river courses, then flooding up over the hills and mountains, melting snows and frozen ground.

With this north-bound flood of sunlit air and warmed earth come the great stirrings of life. Insects creep from their ground or tree wintering homes; ferns uncurl their fiddleheads; frogs rise from their frozen mud; even the present dominator of earth, man, feels a stirring in his blood.

The onrush of spring and recession of frost is erratic, states the U.S. Weather Bureau in Washington, D. C. It can vary as much as a month from year to year.

As a rule, says the Department of Commerce, there is at least one unusually cold or cool spell during the spring weather before it is safe to plant fields or garden.

Throughout the United States, scientists attempt to chart the surge of spring each year by recording the date of the last freezing temperature. These temperatures are accumulated and averaged with those of the past few years and serve as a guide to frost-free weather.

As spring flows north, the last spring freeze to occur in Florida is around Feb. 28. By March 30 frost has receded from South Carolina, Georgia, on through the southern part of Texas. By April 10, North Carolina, Alabama, Mississippi, northern Texas, and the far southwest are unthawed.

The last of April unlocks the great plains, the western coast as far north as Oregon, and the eastern coast as high as New Jersey and lower New York. By May 30, most of the United States has welcomed spring with no fear of frost dangers, except for the high mountains of the Rockies and high land masses in New England and around the Great Lakes.

The steady recession of the frost line lasts for approximately three months, from early March to early June, from the Gulf Coast to the Great Lakes region and northern New England. In far northern areas, reports the Weather Bureau, frosts have been reported in each of the summer months.

When you are planning a garden, the date of freezing is not the only factor. Condition and temperature of the soil and the crop to be planted are equally important.

There are great variations in conditions due to the influence of mountains and valleys. Higher land in the mountainous areas will usually have later frost than the protected valleys where the sun is caught and retained. North slopes will usually be colder than the sunny south slopes. Large bodies of water will have a tempering influence and the areas around lakes will be warmer than those farther inland. If you want to know about the last frost in your own area, check with the local weather bureau.

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AGRICULTURE

Spring Can Come Indoors In Glass Containers

➤ PUT SPRING in a glass jar and set it on your bookcase or your dresser.

For those people who have no outside garden to welcome spring, here's an answer: bring a small garden inside to you.

The way to do it is to make a terrarium, which is a large word meaning a miniature garden enclosed in a clear glass container.

Terrariums artificially produce an ideal moist atmosphere for growing plants that could not survive the normally dry atmosphere of the average home, states T. J. Sheehan, ornamental horticulturist with the Florida Agricultural Experiment Stations in Gainesville, Fla.

Relatively simple to construct, terrariums are easy to keep and plants will thrive for long periods with little care.

These are the steps Mr. Sheehan recommends:

Place about one inch of pea-size gravel on the bottom of the glass container to hold excess water which would otherwise rot the roots.

Cover the gravel with three to four inches of good organic soil mixture (one part by volume of peat to one part sandy soil, plus one teaspoon of 6-6-6 fertilizer for every two quarts of soil). Loosely yet firmly tamp this soil level or shape in slopes for landscaping.

The tiny plants that grow best in this inside garden are: fairy footprints, partridgeberry, maidenhair fern, African violets, creeping fig, English ivy, philodendron scandens and snake plant.

Set the plants in the soil at the same depth they were growing before.

A glass cover helps keep up the humidity and prevents the terrarium from drying out. This cover should be removed for a few hours to ventilate the terrarium when the sides have collected droplets of moisture.

As this garden requires only a small amount of water, it should be watered only when the soil surface is dry, and then add just enough water to moisten the soil.

Keep the glass garden away from direct sunlight, for the plants are accustomed to the dark damp areas in the woods.

The plants will need little or no fertilizer, Mr. Sheehan points out. "The object is to keep the plants healthy but growing slowly, just short of a starvation diet."

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FORESTRY

Dwarf Evergreens Are Nursed for Propagation

➤ MORE THAN A THOUSAND rare tiny trees are being carefully tended for propagation by cuttings and seeds.

The attractive dwarf trees—freaks of nature that occur through mutation of the genes inside the seed cells—were recently given to the National Arboretum, Washington, D. C., by W. T. Gotelli, horticulturist of South Orange, N. J.

The collection includes miniature trees from most of the conifer family—junipers, spruces, yews, hemlocks, pines, firs and cedars. Dwarf conifers may grow as high as six feet at maturity, but many are only a few inches tall when they are 25 or more years old. A 15-year-old Jarvis dwarf hemlock in the collection is small enough to fit into a garden pot.

Conifers are those trees growing in temperate zones that bear cones and have needles for leaves. They are fondly called evergreens because they seem to stay green forever—or at least all winter long. Actually evergreens lose their needle-like leaves like other trees—but gradually instead of all at once.

Most of the dwarf evergreens were collected by Mr. Gotelli from Europe, but many come from Japan, Australia, New Zealand and Canada. They are being planted on four acres of north slope at the Arboretum where they will produce offspring for distribution.

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